

# Renewable Energy as an Emission Control Alternative: Agricultural and Forestry Sector Roles

## There are Many Types of Agriculture and Forest Biofeedstocks

- Agricultural and forestry products:
  - Corn
  - Sugar Cane
  - Timber
- Production residues:
  - Crop Residue
  - Logging Residue
- Processing products and by products:
  - Corn Oil
  - Rendered Animal Fat
  - Milling Residue
- Energy crops:
  - Switchgrass
  - Willow
  - Hybrid Poplar



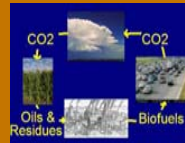
Source: [www.state.ca.us/de/biomass.html](http://www.state.ca.us/de/biomass.html)

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## The Usage of Biofuels Recycles Carbon

- The usage of biofuels displaces coal and oil with *recycled carbon*.
- Biofuel feedstocks remove carbon from the atmosphere during plant growth and release it upon combustion.
- Net GHG emission consequences depend on the amount of fossil fuels used in producing the biofuel feedstocks and transforming them into energy.
- All biofuel production processes, such as
  - growing and harvesting
  - transporting
  - and processing into energy
 should be evaluated for their respective impacts.



## Biofeedstocks Can Be Converted to Several Energy Forms

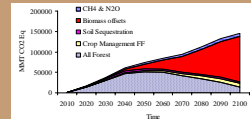
- Biofeedstocks can be put as direct inputs into power plants to substitute for coal and they also can be used to produce liquid fuels such as ethanol and biodiesel:
  - Energy crops, residues and trees replace coal in power plants
  - Ethanol is made from the cellulose content of energy crops, residues and trees
  - Grains and sugarcane are processed into ethanol
  - Fats and oils are made into biodiesel



Source: <http://www.materials.qmul.ac.uk/admissions/programmes/environmental.php>

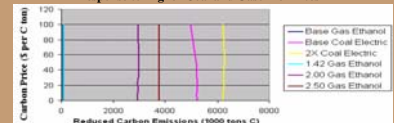
## Biofuels Can Make An Economic, Sustainable Contribution

- Play increasing role as time passes.
- Do not saturate as some other agricultural activities.
- A contribution from carbon price or higher feedstock prices is needed to make biofuels competitive.



Source: Lee, H.C., R.A. McCarl and D. Gillig, "The Dynamic Competitiveness of U.S. Agricultural and Forest Carbon Sequestration," 2003.

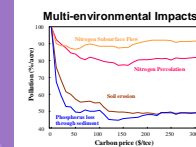
## Carbon Emissions Reductions Due to Biofuel Use in Response to Higher Coal and Gasoline Prices



Note: the results are calculated by authors

## Biofuel Usage Also Benefits Land Owners and The Environment

- Prices and incomes increase. Consumers lose, producers gain.
- Substitution for petroleum contributes to energy security.



- Erosion, and chemical runoff are reduced.
- Some environmental gains have ultimate limits.

Graph source: Patmanash, S.K., A.J. Sommer, B.C. Murray, T. Bondfield, B.A. McCarl, and D. Gillig, "Water Quality Co-Benefits of Greenhouse Gas Reduction Incentives in Agriculture and Forestry," Report to EPA, 2002.

## Offset Rates Computed Through Lifecycle Analysis

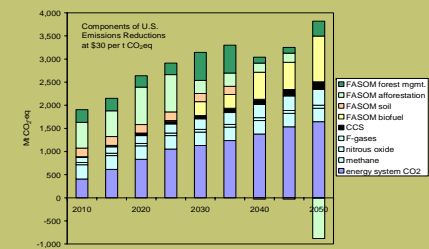
### Net Carbon Emission Reduction (%)

Biomass	Bioproduct	
	Ethanol*	Electricity**
Corn Grain	37	-
Wheat Grain	38	-
Corn Residue	82	97
Wheat Residue	81	97
Rice Residue	78	90
Softwood Residue	59	97
Hardwood Residue	60	97
Switchgrass	82	90
Poplar	62	93
Willow	62	96

\* Compared to gasoline; \*\* Compared to coal-fueled power plants.

Note: the results are calculated by authors.

## Biofuels Can Be Competitive In Terms of Overall Portfolio of Societal GHG Reductions



Source: McCarl, R.A., and R.D. Sands, "Competitiveness Of Terrestrial Greenhouse Gas Offsets: Are They A Bridge To The Future?", 2006.